# PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-102556
(43)Date of publication of application : 13.04.2001

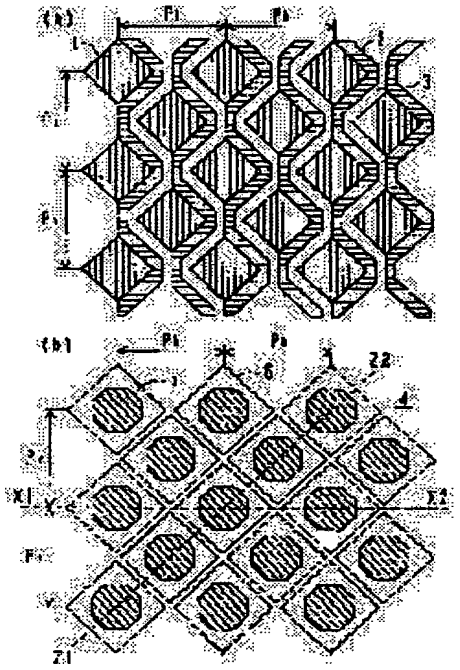
(51)Int.Cl. H01L 27/14
H01L 27/148
H04N 5/335

(21)Application number : 11-273410
(22)Date of filing : 27.09.1999

(71)Applicant : FUJI FILM MICRODEVICES CO LTD
FUJI PHOTO FILM CO LTD
(72)Inventor : YAMADA TETSUO

## (54) SOLID-STATE IMAGE PICKUP DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide high condensing efficiency, while the isotropy of a condensing area is kept by forming on-chip microlenses formed on a solid-state image pickup device having pixel shift structure.
SOLUTION: This solid-state image pickup device has plural pixel shift photoelectric conversion elements, a light-shielding film having light receiving openings on the respective photoelectric conversion elements, an insulating film formed on the light-shielding film and on-chip microlenses, which are formed on the respective light receiving openings across the insulating film, whose planar shapes are squares where the lengths of four sides are almost equal, whose one diagonal is parallel to a line connecting the center points of the light- receiving openings in one row.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Copyright (C); 1998,2003 Japan Patent Office

* NOTICES *

JPO and NCIPI are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

---

CLAIMS

---

[Claim(s)]
[Claim 1] On the front face of the semi-conductor substrate which demarcates a two-dimensional front face, and the (b) aforementioned semi-conductor substrate, in a fixed pitch (a) Two or more trains, Are many optoelectric transducers arranged by the multi-line, and the optoelectric transducer of an odd number train is received. As for the optoelectric transducer of an even number train, the optoelectric-transducer pitch within each train is shifted about 1-/2. As for the optoelectric transducer of even lines, the optoelectric-transducer pitch in each line is shifted about 1-/2 to the optoelectric transducer of odd lines. Said each optoelectric-transducer train Many optoelectric transducers only containing the optoelectric transducer of odd lines or even lines, (c) The light-shielding film which is formed in said semi-conductor substrate upper part, and has light-receiving opening on each optoelectric transducer, (d) Insulator layer formed on said light-shielding film (e) On said each light-receiving opening The solid state camera which is the micro lens on chip formed on both sides of said insulator layer, and has a micro lens on chip with a flat-surface configuration parallel to the line by which one side of the diagonal line connected the central point of a party's light-receiving opening with the square with the neighboring almost equal die length.
[Claim 2] Said micro lens on chip is a solid state camera according to claim 1 whose flat-surface configuration said optoelectric-transducer pitches are a line writing direction and the direction of a train, and are equal, and is a square mostly.
[Claim 3] It is the solid state camera according to claim 1 which is a rhombus with a line writing direction larger [ said optoelectric-transducer pitch ] than the direction of a train, and the flat-surface configuration where said micro lens on chip is long to a line writing direction.
[Claim 4] It is the solid state camera according to claim 1 which is a rhombus with a line writing direction smaller [ said optoelectric-transducer pitch ] than the direction of a train, and the flat-surface configuration where said micro lens on chip is long in the direction of a train.

---

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the structure of the micro lens for inputting a light figure efficiently about a solid state camera.
[0002]
[Description of the Prior Art] In the solid state camera in which many optoelectric transducers were formed on the semi-conductor substrate, the light-shielding film which has opening corresponding to an optoelectric transducer on a substrate is arranged. In order to improve condensing effectiveness, a micro lens is arranged in the opening upper part of a light-shielding film.
[0003] By the way, the structure in which the micro lens was formed on the photo detector which carries out [ ****** ] and has an array is indicated by JP,6-77450,A etc.
[0004] Drawing 1 (a) is the outline top view of the solid state camera which carries out [ ****** ] and has structure.
[0005] The solid state camera here which carries out [ ****** ] and has structure Many optoelectric transducers (light sensing portion) 1 arranged by two or more trains and the multi-line in the fixed pitches Ph and Pv The optoelectric transducer 1 of an even number train so that the optoelectric-transducer pitch Pv within each train may shift to the front face of a semi-conductor substrate about 1-/2 to the optoelectric transducer 1 of an odd number train Moreover, to the optoelectric transducer 1 of odd lines, the optoelectric transducer 1 of even lines is arranged so that the optoelectric-transducer pitch Ph in each line may shift about 1-/2.
[0006] In the optoelectric-transducer train of a single tier, a party's optoelectric-transducer train contains only the optoelectric transducer 1 of an odd number train or an even number train only including the optoelectric transducer 1 of odd lines or even lines. It was formed in the semi-conductor semi-conductor substrate front face between the adjoining optoelectric-transducer trains, and was combined with the optoelectric transducer 1 of the left-hand side in drawing, and two or more transfer channels 2 have extended in the direction of a train, moving in a zigzag direction. The transfer electrode has been arranged at the optoelectric-transducer space which adjoins in the surface upper part of a semi-conductor substrate, and it has extended in the line writing direction, moving in a zigzag direction.
[0007] Two or more isolation regions 3 have extended in the direction of a train, lying in a zigzag line so that the transfer channel 2 and an optoelectric transducer 1 may be separated between each train.
[0008] Furthermore, it has the light-shielding film which has light-receiving opening on each optoelectric transducer 1, and an insulator layer is formed on the light-shielding film, and a micro lens is formed so that the insulator layer may be inserted.
[0009] (Conventional example 1A) The example which applies a micro lens to the solid state camera which carries out [ ****** ] and has structure is shown in drawing 7 . In this case, the square installed in checkers touches at each top-most vertices, and a micro lens is not arranged at the area of abbreviation one half. The field which cannot be covered by the micro lens 6 is expanded substantially, and the problem of remarkable degradation of condensing effectiveness arises.
[0010] The flat-surface configuration of the micro lens 6 in the solid state camera which carries out [ ****** ] and has structure in order to solve the above-mentioned problem is proposed by the same artificer as this application (refer to JP,10-136391,A). This is shown in drawing 8 and drawing 9 .
[0011] (Conventional example 1B) Drawing 8 forms a micro lens 6 circularly on the light sensing portion 1 of the array shown in drawing 1 (a). The area of a micro lens is expandable even to the circumscribed circle to the square of drawing 7 . Although condensing effectiveness increases by this compared with a configuration like drawing 7 , an optical invalid field exists also in this case.
[0012] (Conventional example 1C) Drawing 9 forms a micro lens 6 at an octagon on the light sensing portion 1 of the array shown in drawing 1 (a). The same with forming a micro lens 6 circularly also in this case, although condensing effectiveness increases, it is difficult to lose an optical invalid field theoretically.
[0013]
[Problem(s) to be Solved by the Invention] Theoretically, an optical invalid field can be lost by using the configuration of a micro lens as a hexagon. However, a hexagon must enlarge the horizontal arrangement pitch Ph of the light sensing portion in each train and each line, or the vertical array pitch Pv, in order to maintain the isotropy of a condensing field, since the die length of a horizontal direction and a perpendicular direction differs (Pv>Ph or

Pv<Ph).
[0014] The object of this invention is offering the solid state camera which can avoid amplification of the optical invalid field produced when the conventional micro lens on chip is formed in the solid state camera which carries out [ ****** ] and has structure.
[0015] Other objects of this invention are offering the solid state camera which can acquire condensing high effectiveness, when a micro lens on chip is formed in the solid state camera which carries out [ ****** ] and has structure.
[0016] The object of further others of this invention is offering the solid state camera which can acquire condensing high effectiveness, maintaining the isotropy of a condensing field, when a micro lens on chip is formed in the solid state camera which carries out [ ****** ] and has structure.
[0017]
[Means for Solving the Problem] The solid state camera of this invention in a fixed pitch on the front face of the semi-conductor substrate which demarcates a two-dimensional front face, and said semi-conductor substrate Two or more trains, Are many optoelectric transducers arranged by the multi-line, and the optoelectric transducer of an odd number train is received. As for the optoelectric transducer of an even number train, the optoelectric-transducer pitch within each train is shifted about 1-/2. As for the optoelectric transducer of even lines, the optoelectric-transducer pitch in each line is shifted about 1-/2 to the optoelectric transducer of odd lines. Said each optoelectric-transducer train Many optoelectric transducers only containing the optoelectric transducer of odd lines or even lines, The light-shielding film which is formed in said semi-conductor substrate upper part, and has light-receiving opening on each optoelectric transducer, They are the insulator layer formed on said light-shielding film, and the micro lens on chip formed on both sides of said insulator layer on said each light-receiving opening. It has a micro lens on chip with a flat-surface configuration parallel to the line by which one side of the diagonal line connected the central point of a party's light-receiving opening with the square with the neighboring almost equal die length.
[0018]
[Embodiment of the Invention] Drawing 2 is some expanded sectional views of the solid state camera of this invention.
[0019] The optoelectric transducer 1 of pn junction structure and the transfer channel 2 of n mold field are formed, the transfer channel 2 is adjoined and the isolation region 3 which is p+ mold field is formed in the front face of the semi-conductor substrates 7, such as n mold silicon which has p mold well 11. The front face of an optoelectric transducer 1, the transfer channel 2, and the semi-conductor substrate 7 in which the isolation region 3 was formed is oxidized, and an insulator layer 9 is formed.
[0020] Next, after forming the transfer electrodes 8, such as two-layer polycrystalline silicon, above the transfer channel 2 and forming an insulator layer 9 in it further on it, it consists of aluminum (aluminum) etc. and the light-shielding film 4 which has opening in the optoelectric-transducer 1 upper part is formed above the transfer electrode 8.
[0021] In order to have formed the light-shielding film 4 upwards and to carry out flattening of the front face, the flattening layer 10 which are insulator layers, such as a transparence insulator layer, is formed on a spin coat. The spin coat of the lens layer is carried out with a photopolymer ingredient transparent moreover, pattern NINGU is carried out by the photolithography, and the micro lens 6 on chip is formed using the approach of making it fluidizing by heat treatment etc.
[0022] The 1st example of this invention is explained using drawing 1 (a) and drawing 1 (b).
[0023] This example improves the configuration of the micro lens of the above-mentioned conventional examples 1A-1C, and arrangement, shows and makes [ ****** ] an optoelectric transducer etc. drawing 1 (a) like the conventional examples 1A-1C, and has structure.
[0024] namely, the lines of the photo detector 1 which adjoins mutually — setting — the array of the photo detector 1 of one line — the array of the photo detector 1 of the line of another side — receiving — about [ of this array spacing Ph ] — only one half, it shifts relatively and is arranged.
[0025] Between the photo detectors 1 which furthermore adjoin a line writing direction, the direction transfer channel 2 of a train for two trains has been arranged, the direction transfer channel 2 of a train for one train has been arranged between the photo detectors 1 which adjoin in the direction of slant, and the configuration currently formed on the semi-conductor substrate so that the direction transfer channel 2 of a train may move between photo detectors 1 in a zigzag direction is adopted.
[0026] At this time, the horizontal array pitch Ph and the vertical array pitch Pv of a photo detector 1 in each train and each line are equal in the 1st example (condition of Ph=Pv). And as shown in drawing 1 (b), the photo detector 1 grade was formed upwards and a light-shielding film 4 is formed. The light-receiving opening 5 is opened in this light-shielding film 4 by the right above section of two or more photo detectors 1 corresponding to each. For this reason, the light-receiving opening 5 also becomes the same array as a photo detector 1. That is, it is equal [ the horizontal array pitch and vertical array pitch of the light-receiving opening 5 in each train and each line ] to the pitches Ph and Pv of a photo detector.
[0027] By this example, the configuration of an octagon which is adjusted at the meandering include angle of each direction transfer channel 2 of a train is used for the configuration of the light-receiving opening 5. Light-receiving area is expandable to the maximum with this configuration. In addition, the configuration of the light-receiving opening 5 may not be restricted to an octagon, for example, circular, an ellipse form, a rectangle, etc. are sufficient

as it.
[0028] Next, as shown in drawing 2 , the flattening layer 10 is formed on a light-shielding film 4, and right above each photo detector 1, a micro lens 6 is formed so that the flattening layer 10 may be pinched. As shown in drawing 1 (b), let the flat-surface configuration of a micro lens 6 be a rhombus.
[0029] It is equal to the horizontal array pitch Ph, or the die length of the horizontal diagonal line is small by spacing with the micro lens 6 which adjoins rather than it, and is formed, and the die length of the vertical diagonal line has it, or a micro lens 6 has it by spacing with the micro lens 6 which adjoins rather than it, and is formed. [ small ] [ still more nearly equal to the vertical array pitch Pv ] Thereby, the configuration of a micro lens 6 changes corresponding to the die length of the horizontal array pitch Ph and the vertical array pitch Pv.
[0030] A micro lens 6 is installed so that the diagonal line horizontal to the line which connected the central point of a party's light-receiving opening 5 may be parallel.
[0031] The micro lens 6 formed here is a square with the neighboring equal die length, as shown with a broken line. Moreover, since it is Pv=Ph, the configuration of a micro lens 6 serves as a square mostly.
[0032] Drawing 3 (a) and (b) show the cross-section structure at the time of forming the micro lens 6 of the 1st example of this invention by the well-known micro-lens manufacture approach. Drawing 3 (a) is the sectional view of the direction (Z1-Z2 of drawing 1 (b)) of 45 slant, and drawing 3 (b) is a horizontal (X1-X2 of drawing 1 (b)) sectional view. Both can condense both incident light to the light-receiving opening 5, although curvatures differ.
[0033] Since the curvature of a micro lens changes with directions, the image after micro-lens touch-down is distorted. However, the image information which one optoelectric transducer supplies is the information on the point in an image, and the distortion of an image does not pose a problem.
[0034] The modification of the 1st example of this invention is shown in drawing 4 . Except [ all ] the configuration of a micro lens 6, it is the same as that of the 1st example. The micro lens 6 of drawing 4 (a) is the thing of the configuration which beveled the four corners of the micro lens 6 of the 1st example of this invention, as shown with a broken line.
[0035] Drawing 4 (b) is the enlarged drawing of a micro lens 6. The micro lens 6 which bevels the broken-line part of a micro lens 6 shown in left-hand side and by which this example shown in right-hand side was beveled is formed. You may be a curved surface although the chamfer serves as a flat surface here. By beveling each part, the difference of the major axis of a micro lens and a minor axis decreases, and the variation rate from the spherical surface on the front face of a lens decreases. Control of a lens curved surface becomes easy and improvement in condensing effectiveness can be expected.
[0036] The 2nd example of this invention is shown in drawing 5 . Although an optoelectric transducer etc. is ****** carried out, it has structure and it is the same as that of the 1st example fundamentally, the horizontal array pitch Ph of a photo detector 1 is large from the vertical array pitch Pv in each train and each line (condition of Ph>Pv). That is, it is a horizontally long configuration.
[0037] Since the light-receiving opening 5 has the almost same array pitch as a photo detector 1, it becomes larger [ the horizontal array pitch of the light-receiving opening 5 in each train and each line ] than a vertical array pitch. Moreover, the configuration of the light-receiving opening 5 is carrying out the configuration of an octagon which is adjusted at the meandering include angle of each direction transfer channel 2 of a train also in this example. Therefore, the configuration of the light-receiving opening 5 becomes a horizontally long octagon in this case.
[0038] As a cross-section configuration of the thickness direction, as shown in drawing 2 , like the 1st example, the flattening layer 10 is formed on a light-shielding film 4, and right above each photo detector 1, a micro lens 6 is formed so that the flattening layer 10 may be pinched. A micro lens 6 is installed in the line which connected the central point of a party's light-receiving opening 5 so that one diagonal line may be parallel.
[0039] In addition, the configuration of the light-receiving opening 5 is not restricted to an octagon. For example, circular, an ellipse form, a rectangle, etc. are sufficient. The configuration to which a micro lens 6 can introduce as many incident light as possible in the light-receiving opening 5 is desirable.
[0040] The configuration serves as a horizontally long rhombus so that it may be shown with a broken line, since the neighboring die length of the micro lens 6 formed here is equal and it is Pv<Ph.
[0041] In addition, the corner of a rhombus may be beveled as shown in drawing 4 . In this description, it is called a rhombus etc. also including the configuration which beveled in this way.
[0042] The 3rd example of this invention is shown in drawing 6 . Although optoelectric-transducer 1 grade is ****** carried out, has structure and is the same as that of the 1st example fundamentally, the horizontal array pitch Ph of a photo detector 1 is narrow from the vertical array pitch Pv in each train and each line (condition of Ph<Pv). That is, it is the configuration of being perpendicularly long.
[0043] Since the light-receiving opening 5 has the almost same array pitch as a photo detector 1, it becomes narrower [ the horizontal array pitch of the light-receiving opening 5 in each train and each line ] than a vertical array pitch. Moreover, the configuration of the light-receiving opening 5 is carrying out the configuration of an octagon which is adjusted at the meandering include angle of each direction transfer channel 2 of a train also in this example. Therefore, the configuration of the light-receiving opening 5 becomes a perpendicularly long octagon in this case. In addition, the configuration of the light-receiving opening 5 is not restricted to an octagon. For example, circular, an ellipse form, a rectangle, etc. are sufficient.
[0044] As a cross-section configuration of the thickness direction, as shown in drawing 2 , like the above-mentioned example, the flattening layer 10 is formed on a light-shielding film 4, and right above each photo detector 1, a micro lens 6 is formed so that the flattening layer 10 may be pinched. A micro lens 6 is installed in the line which

connected the central point of a party's light-receiving opening so that one diagonal line may be parallel.
[0045] In addition, the configuration of the light-receiving opening 5 is not restricted to an octagon. For example, circular, an ellipse form, a rectangle, etc. are sufficient. The configuration to which a micro lens 6 can introduce as many incident light as possible in the light-receiving opening 5 is desirable.
[0046] It becomes a perpendicularly long rhombus so that it may show the configuration with a broken line, since the neighboring die length of the micro lens 6 formed here is equal and it is Pv>Ph. In addition, a rhombus may bevel a corner as mentioned above.
[0047] Although this invention was explained in accordance with the example above, this invention is not restricted to these. For example, probably, it will be obvious to this contractor for various modification, amelioration, combination, etc. to be possible.
[0048]
[Effect of the Invention] As explained above, according to this invention, amplification of the optical invalid field produced when the conventional micro lens on chip is formed in the solid state camera which carries out [ ****** ] and has structure is avoidable.
[0049] Moreover, when a micro lens on chip is formed in the solid state camera which carries out [ ****** ] and has structure, condensing high effectiveness is acquired.
[0050] Condensing high effectiveness can be acquired maintaining the isotropy of a condensing field, when a micro lens on chip is formed in the solid state camera which carries out [ ****** ] and has structure further again.

---

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

---

DESCRIPTION OF DRAWINGS

---

[Brief Description of the Drawings]
[Drawing 1] It is the outline top view showing the 1st example of this invention.
[Drawing 2] They are some expanded sectional views of the solid state camera of this invention.
[Drawing 3] It is the sectional view showing the micro lens of the 1st example of this invention.
[Drawing 4] It is the outline top view showing the modification of the 1st example of this invention.
[Drawing 5] It is the outline top view showing the 2nd example of this invention.
[Drawing 6] It is the outline top view showing the 3rd example of this invention.
[Drawing 7] It is the outline top view showing one gestalt of the 1st conventional example.
[Drawing 8] It is the outline top view showing other gestalten of the 1st conventional example.
[Drawing 9] It is the outline top view showing the gestalt of further others of the 1st conventional example.
[Description of Notations]
1 [ — A light-shielding film, 5 / — Light-receiving opening, 6 / — A micro lens, 7 / — A semi-conductor substrate, 8 / — A transfer electrode, 9 / — An insulator layer, 10 / — A flattening layer, 11 / — Well ] — A photo detector (light sensing portion), 2 — The direction transfer channel of a train, 3 — An isolation region, 4

---

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（A）　(11)特許出願公開番号
特開2001－102556
(P2001－102556A)
(43)公開日　平成13年４月13日(2001.4.13)

| (51)Int.Cl.⁷ | 識別記号 | FI | テーマコード（参考） |
|---|---|---|---|
| H01L 27/14 | | H04N 5/335 | V 4M118 |
| 27/148 | | | U 5C024 |
| H04N 5/335 | | H01L 27/14 | D |
| | | | B |

審査請求　未請求　請求項の数４　ＯＬ　（全７頁）

(21)出願番号　特願平11－273410

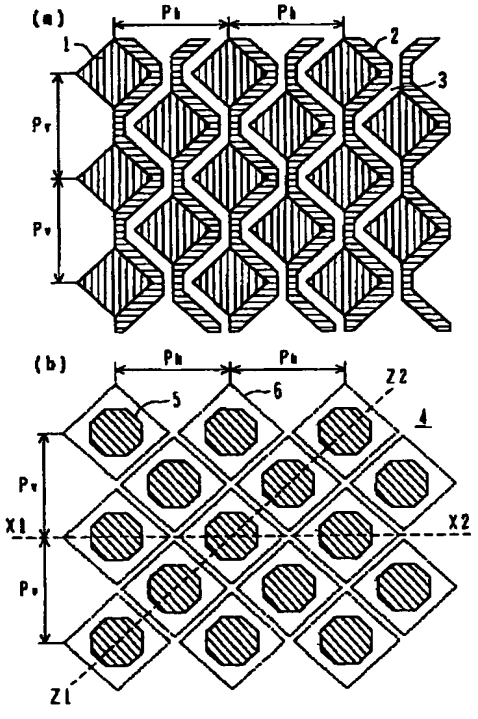
(22)出願日　平成11年９月27日(1999.9.27)

(71)出願人　391051588
富士フイルムマイクロデバイス株式会社
宮城県黒川郡大和町松坂平１丁目６番地
(71)出願人　000005201
富士写真フイルム株式会社
神奈川県南足柄市中沼210番地
(72)発明者　山田　哲生
宮城県黒川郡大和町松坂平１丁目６番地
富士フイルムマイクロデバイス株式会社内
(74)代理人　100091340
弁理士　高橋　敬四郎　（外１名）

最終頁に続く

(54)【発明の名称】　固体撮像装置

(57)【要約】
【課題】　画素ずらし構造を有する固体撮像装置にオンチップマイクロレンズを形成した、集光領域の等方性を保ちながら、高い集光効率を得る。
【解決手段】　固体撮像装置は、多数個の画素ずらし光電変換素子と、各光電変換素子上に受光開口を有する遮光膜と、前記遮光膜上に形成される絶縁膜と、各受光開口上に、前記絶縁膜を挟んで形成されるオンチップマイクロレンズであって、平面形状が四辺の長さがほぼ等しい四角形でその対角線の一方が、一行の受光開口の中心点を結んだ線に平行であるオンチップマイクロレンズとを有する。



1

【特許請求の範囲】

【請求項１】　（ａ）２次元表面を画定する半導体基板と、

（ｂ）前記半導体基板の表面に一定のピッチで複数列、複数行に配列された多数個の光電変換素子であって、奇数列の光電変換素子に対し、偶数列の光電変換素子は各列内の光電変換素子ピッチの約１／２ずれており、奇数行の光電変換素子に対し偶数行の光電変換素子は各行内の光電変換素子ピッチの約１／２ずれており、前記各光電変換素子列は、奇数行又は偶数行の光電変換素子のみを含む多数個の光電変換素子と、

（ｃ）　前記半導体基板上方に形成され、各光電変換素子上に受光開口を有する遮光膜と、

（ｄ）　前記遮光膜上に形成される絶縁膜と、

（ｅ）　前記各受光開口上に、前記絶縁膜を挟んで形成されるオンチップマイクロレンズであって、平面形状が四辺の長さがほぼ等しい四角形でその対角線の一方が、一行の受光開口の中心点を結んだ線に平行であるオンチップマイクロレンズとを有する固体撮像装置。

【請求項２】　前記光電変換素子ピッチは、行方向と列方向で等しく、

前記オンチップマイクロレンズは、平面形状がほぼ正方形である請求項１に記載の固体撮像装置。

【請求項３】　前記光電変換素子ピッチは、行方向が列方向より大きく、

前記オンチップマイクロレンズは、平面形状が行方向に長い菱形である請求項１に記載の固体撮像装置。

【請求項４】　前記光電変換素子ピッチは、行方向が列方向より小さく、

前記オンチップマイクロレンズは、平面形状が列方向に長い菱形である請求項１に記載の固体撮像装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、固体撮像装置に関し、特に光像を効率的に入力するためのマイクロレンズの構造に関する。

【０００２】

【従来の技術】半導体基板上に多数の光電変換素子を形成した固体撮像装置において、基板上に光電変換素子に対応した開口を有する遮光膜が配置される。集光効率を向上するためには遮光膜の開口上方にマイクロレンズが配置される。

【０００３】ところで、画素ずらし配列を持つ受光素子上にマイクロレンズを形成した構造は、例えば特開平６－７７４５０等に記載されている。

【０００４】図１（ａ）は、画素ずらし構造をもつ固体撮像装置の概略平面図である。

【０００５】ここでいう画素ずらし構造をもつ固体撮像装置は、一定のピッチＰｈ及びＰｖで複数列、複数行に配列された多数個の光電変換素子（受光部）1が、半導

2

体基板の表面に、奇数列の光電変換素子１に対し、偶数列の光電変換素子１は各列内の光電変換素子ピッチＰｖの約１／２ずれるように、また、奇数行の光電変換素子１に対し偶数行の光電変換素子１は各行内の光電変換素子ピッチＰｈの約１／２ずれるように配置される。

【０００６】一列の光電変換素子列は、奇数行又は偶数行の光電変換素子１のみを含み、一行の光電変換素子列は、奇数列又は偶数列の光電変換素子１のみを含む。複数の転送チャネル２は、隣接する光電変換素子列間の半導体半導体基板表面に形成され、図中左側の光電変換素子１と結合され、蛇行しつつ列方向に延在している。転送電極は、半導体基板の表面上方で隣接する光電変換素子行間に配置され、蛇行しつつ行方向に延在している。

【０００７】複数の分離領域３は、転送チャネル２と光電変換素子１とを各列間で分離するように、蛇行しつつ列方向に延在している。

【０００８】さらに、各光電変換素子１上に受光開口を有する遮光膜を有し、その遮光膜の上に絶縁膜を形成し、その絶縁膜を挟むようにマイクロレンズを形成する。

【０００９】（従来例１Ａ）画素ずらし構造をもつ固体撮像装置にマイクロレンズを適用する例を図７に示す。この場合、市松状に設置された正方形が各頂点で接し、約半分の面積にはマイクロレンズが配置されない。マイクロレンズ６で覆うことの出来ない領域が大幅に拡大し、集光効率の著しい劣化という問題が生じる。

【００１０】上記問題を改善する目的で、画素ずらし構造をもつ固体撮像装置におけるマイクロレンズ６の平面形状が、本願と同一の発明者によって提案されている（特開平１０－１３６３９１号参照）。これを図８及び図９に示す。

【００１１】（従来例１Ｂ）図８は、図１（ａ）に示す配列の受光部1の上に、マイクロレンズ６を円形に形成したものである。図７の正方形に対し、その外接円にまでマイクロレンズの面積を拡大できる。これにより、図７のような形状に比べ、集光効率は増大するが、この場合にも、光学的無効領域は存在する。

【００１２】（従来例１Ｃ）図９は、図１（ａ）に示す配列の受光部1の上に、マイクロレンズ６を八角形に形成したものである。この場合も、マイクロレンズ６を円形に形成するのと同様、集光効率は増大するが、原理的に光学的無効領域をなくすことは困難である。

【００１３】

【発明が解決しようとする課題】原理的には、マイクロレンズの形状を六角形にすることで光学的無効領域をなくすことが出来る。しかし、六角形は、水平方向と垂直方向の長さが異なるので、集光領域の等方性を保つためには、各列内及び各行内の受光部の水平配列ピッチＰｈと垂直配列ピッチＰｖのいずれかを大きく（Ｐｖ＞Ｐｈ

3

又はＰｖ＜Ｐｈ）しなければならない。

【００１４】本発明の目的は、画素ずらし構造を有する固体撮像装置に従来のオンチップマイクロレンズを形成した場合に生ずる光学的無効領域の拡大を回避することのできる固体撮像装置を提供することである。

【００１５】本発明の他の目的は、画素ずらし構造を有する固体撮像装置にオンチップマイクロレンズを形成した場合に高い集光効率を得られる固体撮像装置を提供することである。

【００１６】本発明のさらに他の目的は、画素ずらし構造を有する固体撮像装置にオンチップマイクロレンズを形成した場合に集光領域の等方性を保ちながら、高い集光効率を得られる固体撮像装置を提供することである。

【００１７】

【課題を解決するための手段】本発明の固体撮像装置は、２次元表面を画定する半導体基板と、前記半導体基板の表面に一定のピッチで複数列、複数行に配列された多数個の光電変換素子であって、奇数列の光電変換素子に対し、偶数列の光電変換素子は各列内の光電変換素子ピッチの約１／２ずれており、奇数行の光電変換素子に対し偶数行の光電変換素子は各行内の光電変換素子ピッチの約１／２ずれており、前記各光電変換素子列は、奇数行又は偶数行の光電変換素子のみを含む多数個の光電変換素子と、前記半導体基板上方に形成され、各光電変換素子上に受光開口を有する遮光膜と、前記遮光膜上に形成される絶縁膜と、前記各受光開口上に、前記絶縁膜を挟んで形成されるオンチップマイクロレンズであって、平面形状が四辺の長さがほぼ等しい四角形でその対角線の一方が、一行の受光開口の中心点を結んだ線に平行であるオンチップマイクロレンズとを有する。

【００１８】

【発明の実施の形態】図２は、本発明の固体撮像装置の一部の拡大断面図である。

【００１９】ｐ型ウェル１１を有するｎ型シリコン等の半導体基板７の表面に例えばｐｎ接合構造の光電変換素子１と、ｎ型領域の転送チャネル２を形成し、転送チャネル２に隣接して$p^+$型領域である分離領域３を形成する。光電変換素子１、転送チャネル２、分離領域３を形成した半導体基板７の表面を酸化して、絶縁膜９を形成する。

【００２０】次に、転送チャネル２の上方に、２層多結晶シリコン等の転送電極８を形成し、その上に、さらに絶縁膜９を形成した後、Ａｌ（アルミニュウム）等からなり、光電変換素子１上方に開口を有する遮光膜４を転送電極８の上方に形成する。

【００２１】遮光膜４を形成した上に、表面を平坦化するために、透明絶縁膜等の絶縁膜である平坦化層１０をスピンコートで形成する。その上に、透明な感光性樹脂材料でレンズ層をスピンコートし、フォトリソグラフィによりパターンニングし、熱処理により流動化させる方法等を利用してオンチップマイクロレンズ６が形成される。

4

【００２２】図１（ａ）及び図１（ｂ）を用いて、本発明の第１の実施例を説明する。

【００２３】本実施例は、前述の従来例１Ａ～１Ｃのマイクロレンズの形状及び配置を改善するものであり、光電変換素子等は従来例１Ａ～１Ｃ同様、図１（ａ）に示す画素ずらし構造を有している。

【００２４】すなわち、互いに隣接する受光素子１の行同士において、一方の行の受光素子１の配列が他方の行の受光素子１の配列に対して該配列間隔Ｐｈのほぼ１／２だけ相対的にずれて配置されている。

【００２５】さらに行方向に隣接する受光素子１間には２列分の列方向転送チャネル２が配置され、斜め方向に隣接する受光素子１間には１列分の列方向転送チャネル２が配置され、列方向転送チャネル２が受光素子１間を蛇行するように半導体基板上に形成されている構成を採用している。

【００２６】この時、第１の実施例では、各列内及び各行内の受光素子１の水平配列ピッチＰｈと垂直配列ピッチＰｖが等しくなっている（Ｐｈ＝Ｐｖの状態）。そして、図１（ｂ）に示すように、受光素子１等が形成された上に、遮光膜４が形成される。この遮光膜４には、複数の受光素子１の直上部にそれぞれに対応して受光開口５があけられる。このため、受光開口５も、受光素子１と同様の配列になる。つまり、各列内及び各行内の受光開口５の水平配列ピッチと垂直配列ピッチも受光素子のピッチＰｈ、Ｐｖと等しくなっている。

【００２７】受光開口５の形状は、本実施例では、各列方向転送チャネル２の蛇行角度に整合するような八角形の形状を採用している。この形状により受光面積を最大限に拡大することができる。なお、受光開口５の形状は、八角形に限られず、例えば、円形、楕円形、方形等でもよい。

【００２８】次に、図２に示すように、遮光膜４の上に、平坦化層１０を形成し、その平坦化層１０を挟むように、それぞれの受光素子１の真上にマイクロレンズ６を形成する。マイクロレンズ６の平面形状は、図１（ｂ）に示すように菱形とする。

【００２９】マイクロレンズ６は、水平方向の対角線の長さが、水平配列ピッチＰｈと等しいか、それよりも隣接するマイクロレンズ６との間隔分小さく形成され、さらに、垂直方向の対角線の長さは、垂直配列ピッチＰｖと等しいか、それよりも隣接するマイクロレンズ６との間隔分小さく形成される。これにより、マイクロレンズ６の形状は、水平配列ピッチＰｈ及び垂直配列ピッチＰｖの長さに対応して変化する。

【００３０】マイクロレンズ６は、一行の受光開口５の中心点を結んだ線に、水平方向の対角線が平行になるように設置される。

5

【００３１】ここで形成されるマイクロレンズ６は、破線でしめすように、四辺の長さの等しい四角形である。また、Ｐｖ＝Ｐｈであるので、マイクロレンズ６の形状は、ほぼ正方形となる。

【００３２】図３（ａ）、（ｂ）は、本発明の第１の実施例のマイクロレンズ６を周知のマイクロレンズ製造方法で形成した場合の断面構造を示す。図３（ａ）は、斜め４５度方向（図１（ｂ）のＺ１－Ｚ２）の断面図であり、図３（ｂ）は、水平方向（図１（ｂ）のＸ１－Ｘ２）の断面図である。両者は、曲率は異なるが、共に入射光を受光開口５に集光することが出来る。

【００３３】マイクロレンズの曲率が方向により変化するため、マイクロレンズ接地後の画像は歪む。しかし、一つの光電変換素子が供給する画像情報は画像中の点の情報であり画像の歪みは問題とならない。

【００３４】図４に本発明の第１の実施例の変形例を示す。マイクロレンズ６の形状以外は、全て第１の実施例と同様である。図４（ａ）のマイクロレンズ６は、破線でしめすように、本発明の第１の実施例のマイクロレンズ６の四隅を面取りした形状のものである。

【００３５】図４（ｂ）は、マイクロレンズ６の拡大図である。左側にしめすマイクロレンズ６の破線部分を面取りして、右側に示す本実施例の面取りされたマイクロレンズ６を形成する。ここでは面取り部は平面となっているが、曲面であってもよい。各部を面取りすることにより、マイクロレンズの長径と短径の差が減少し、レンズ表面の球面からの変位が減少する。レンズ曲面の制御が容易となり、集光効率の向上を期待できる。

【００３６】図５に本発明の第２の実施例を示す。光電変換素子等は画素ずらし構造を有しており、基本的には、第１の実施例と同様であるが、各列内及び各行内において、受光素子１の水平配列ピッチＰｈが、垂直配列ピッチＰｖより広くなっている（Ｐｈ＞Ｐｖの状態）。つまり、水平方向に長い形状となっている。

【００３７】受光開口５は、受光素子１とほぼ同一の配列ピッチを有するので、各列内及び各行内の受光開口５の水平配列ピッチも垂直配列ピッチより広くなる。また、受光開口５の形状は、本実施例においても、各列方向転送チャネル２の蛇行角度に整合するような八角形の形状をしている。よって、受光開口５の形状は、この場合、水平方向に長い八角形になる。

【００３８】厚さ方向の断面形状としては、図２に示すように、第１の実施例同様、遮光膜４の上に、平坦化層１０を形成し、その平坦化層１０を挟むように、それぞれの受光素子１の真上にマイクロレンズ６を形成する。マイクロレンズ６は、一行の受光開口５の中心点を結んだ線に、一方の対角線が平行になるように設置される。

【００３９】なお、受光開口５の形状は、八角形に限られない。例えば、円形、楕円形、方形等でもよい。マイクロレンズ６が入射光をなるべく多く受光開口５内に導

6

入できる形状が好ましい。

【００４０】ここで形成されるマイクロレンズ６は、四辺の長さが等しく、Ｐｖ＜Ｐｈであるので、破線でしめすように、その形状は、水平方向に長い菱形となる。

【００４１】なお、図４に示すように菱形の角部を面取りしてもよい。本明細書においては、このように面取りした形状も含めて菱形等と呼ぶ。

【００４２】図６に本発明の第３の実施例を示す。光電変換素子１等は画素ずらし構造を有しており、基本的には、第１の実施例と同様であるが、各列内及び各行内において、受光素子１の水平配列ピッチＰｈが、垂直配列ピッチＰｖより狭くなっている（Ｐｈ＜Ｐｖの状態）。つまり、垂直方向に長い形状となっている。

【００４３】受光開口５は、受光素子１とほぼ同一の配列ピッチを有するので、各列内及び各行内の受光開口５の水平配列ピッチも垂直配列ピッチより狭くなる。また、受光開口５の形状は、本実施例においても、各列方向転送チャネル２の蛇行角度に整合するような八角形の形状をしている。よって、受光開口５の形状は、この場合、垂直方向に長い八角形になる。なお、受光開口５の形状は、八角形に限らない。例えば、円形、楕円形、方形等でもよい。

【００４４】厚さ方向の断面形状としては、図２に示すように、上記実施例同様、遮光膜４の上に、平坦化層１０を形成し、その平坦化層１０を挟むように、それぞれの受光素子１の真上にマイクロレンズ６を形成する。マイクロレンズ６は、一行の受光開口の中心点を結んだ線に、一方の対角線が平行になるように設置される。

【００４５】なお、受光開口５の形状は、八角形に限られない。例えば、円形、楕円形、方形等でもよい。マイクロレンズ６が入射光をなるべく多く受光開口５内に導入できる形状が好ましい。

【００４６】ここで形成されるマイクロレンズ６は、四辺の長さが等しく、Ｐｖ＞Ｐｈであるので、その形状は、破線でしめすように、垂直方向に長い菱形となる。なお、上述のように菱形は角部を面取りしてもよい。

【００４７】以上実施例に沿って本発明を説明したが、本発明はこれらに制限されるものではない。例えば、種々の変更、改良、組合せ等が可能なことは当業者に自明であろう。

【００４８】

【発明の効果】以上説明したように、本発明によれば、画素ずらし構造を有する固体撮像装置に従来のオンチップマイクロレンズを形成した場合に生ずる光学的無効領域の拡大を回避することができる。

【００４９】また、画素ずらし構造を有する固体撮像装置にオンチップマイクロレンズを形成した場合に高い集光効率が得られる。

【００５０】さらにまた、画素ずらし構造を有する固体撮像装置にオンチップマイクロレンズを形成した場合に

7

集光領域の等方性を保ちながら、高い集光効率を得ることが出来る。

【図面の簡単な説明】

【図１】本発明の第１の実施例を示す概略平面図である。

【図２】本発明の固体撮像装置の一部の拡大断面図である。

【図３】本発明の第１の実施例のマイクロレンズを示す断面図である。

【図４】本発明の第１の実施例の変形例を示す概略平面図である。

【図５】本発明の第２の実施例を示す概略平面図である。

8

【図６】本発明の第３の実施例を示す概略平面図である。

【図７】第１の従来例の一形態を示す概略平面図である。

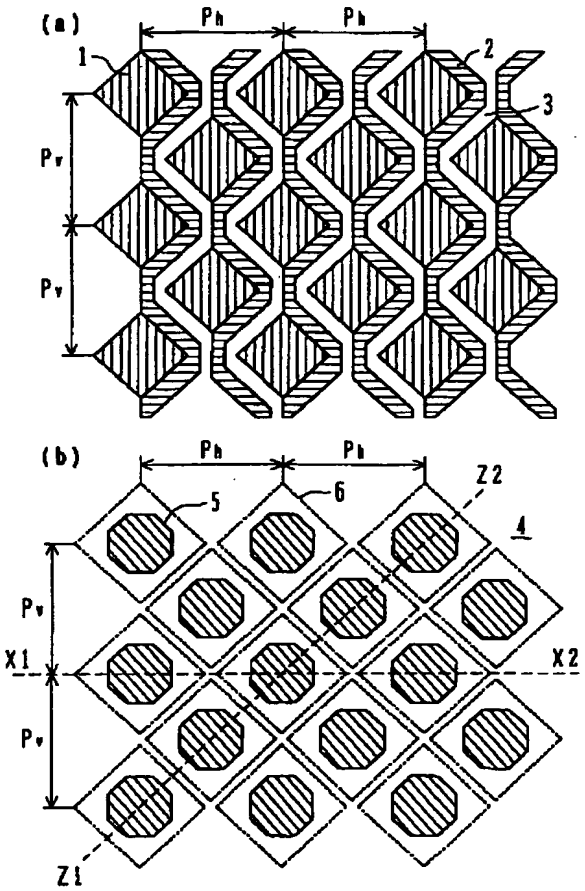
【図８】第１の従来例の他の形態を示す概略平面図である。

【図９】第１の従来例のさらに他の形態を示す概略平面図である。

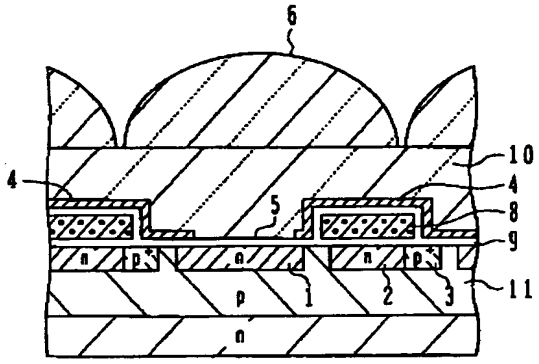
【符号の説明】

１…受光素子（受光部）、２…列方向転送チャネル、３…分離領域、４…遮光膜、５…受光開口、６…マイクロレンズ、７…半導体基板、８…転送電極、９…絶縁膜、１０…平坦化層、１１…ウェル

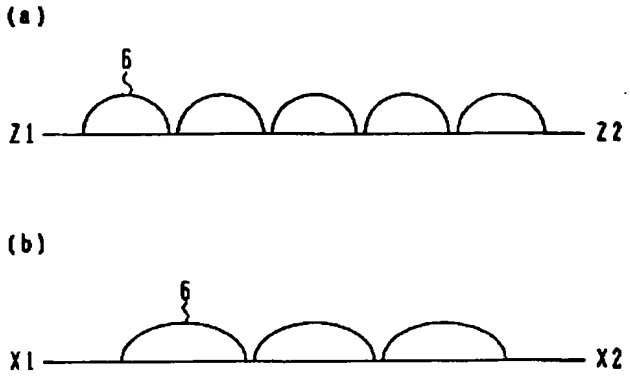
【図１】



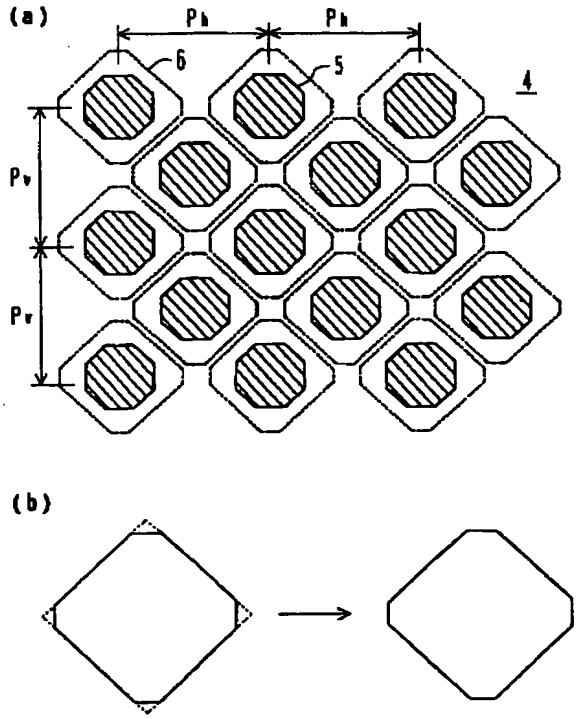

【図２】



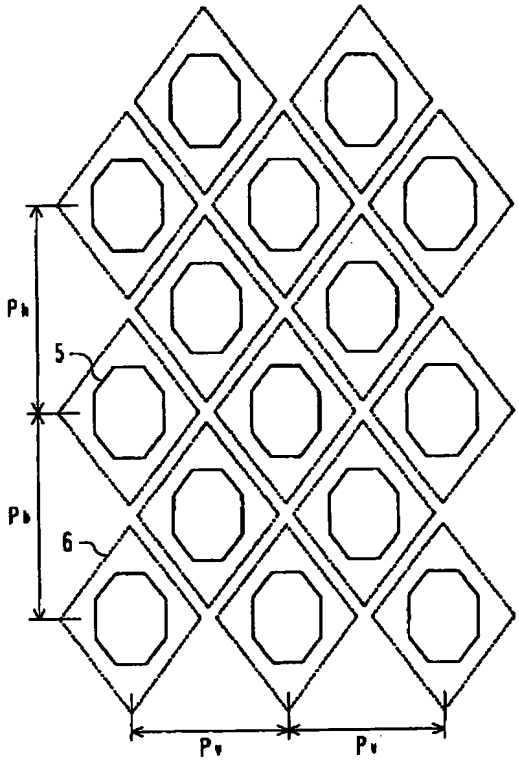

【図３】



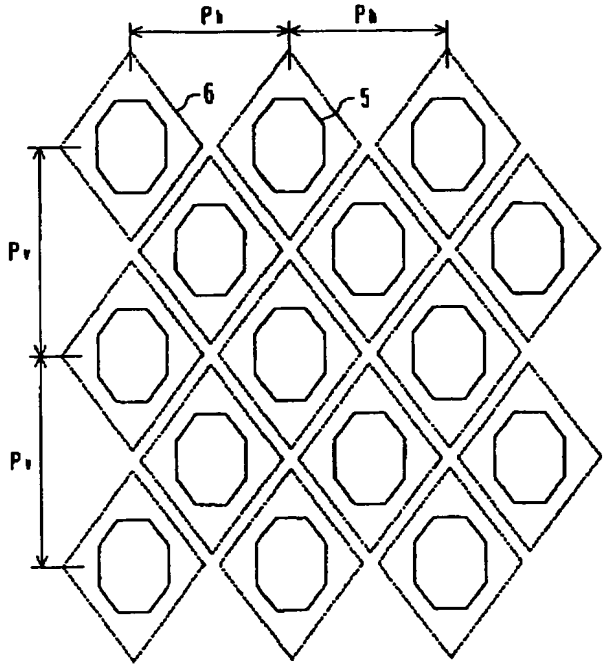
【図４】



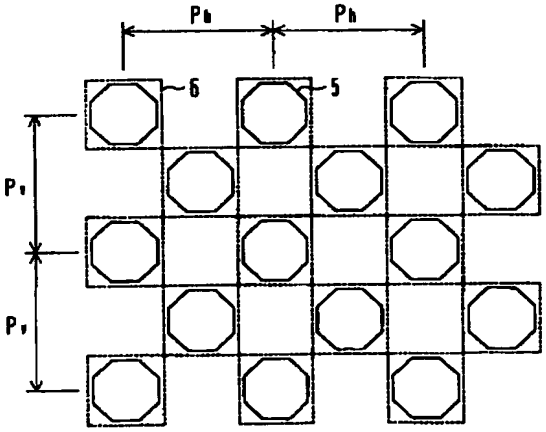

【図５】



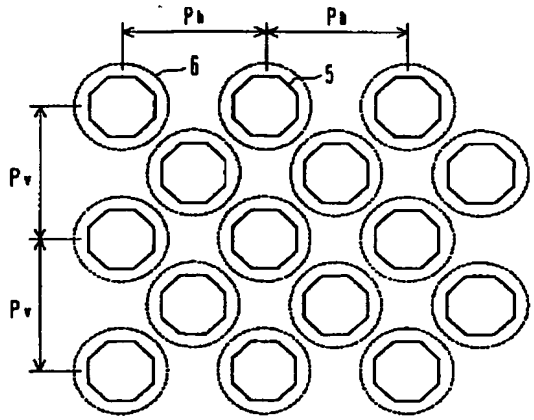

【図６】



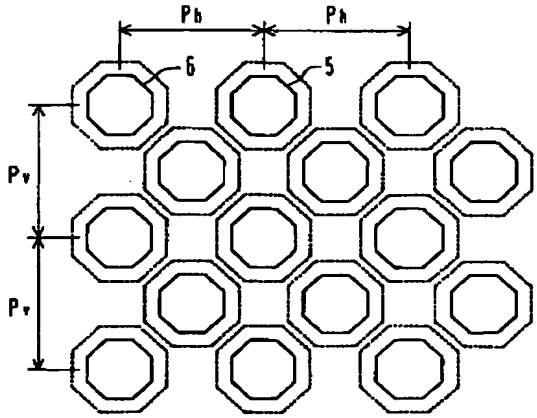

【図７】



【図８】




【図９】




フロントページの続き

Ｆターム(参考)　4M118 AA01 AA06 AB01 BA10 CA03
CA19 CA20 DA12 FA02 FA06
GB11 GD04 GD06
5C024 AA01 CA12 EA04 FA01 FA12
GA51

**This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record**

# BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

**IMAGES ARE BEST AVAILABLE COPY.**
**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**